

# External evaluation of mobile phone technology-based nutrition and agriculture advisory services in Africa and South Asia

Desk-review: Smallholder farming, nutrition and m-  
Agriculture services in Ghana

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## Executive summary

### Introduction

This desk-based review forms part of the external impact evaluation of m-Nutrition in Ghana. The evaluation is being conducted by a consortium of researchers from Gamos, the Institute of Development Studies (IDS) and the International Food Policy Research Institute (IFPRI). M-Nutrition is a global initiative supported by DFID, organised by GSMA, and implemented by in-country mobile network operators (MNOs) to use mobile technology to improve the nutritional status of children and their mothers. In Ghana m-Nutrition is added to the existing m-Agriculture platform Farmers' Club, a service that offers agricultural information via SMS (short message service) and voice, access to an expert helpline and free calls to other Farmers' Club members.

### Objectives of the desk review

Informed by the primary outcomes of the impact evaluation (i.e. to assess the impact of m-nutrition on income, productivity and dietary diversity of smallholder farmers), the review will summarise existing evidence on:

- a) Characteristics of smallholder agriculture in Ghana (with a specific focus on agriculture production and income);
- b) Determinants of dietary intake in rural Ghana; and
- c) The use of mobile phones for agriculture in Ghana (with a specific focus on factors that may influence up-take of mobile phone-based information).

### Findings

#### *Smallholder farmers in Ghana*

Smallholder farmers are the poorest population group in Ghana and also contribute most to existing national poverty. Smallholder farmers constitute the backbone of Ghana's agriculture and produce up to 80 per cent of total agrarian production. Smallholder agriculture in Ghana means mainly subsistence, rain-fed farming, with only rudimentary technology and limited use of agricultural inputs.

Despite the similarities, smallholder farmers are a heterogeneous group, with each group having specific information needs. Smallholders differ depending on whether they pursue subsistence or market-oriented production; are male or female; which farming system they employ; which crops they cultivate; whether they engage in non-farm economic activities; and/or are in the process of transition to a medium size farm.

Women play a key role in smallholder agriculture; they make up 50 per cent of the agricultural labour force and produce more than 70 per cent of the food staples for consumption. Nevertheless, women have limited access to agricultural resources, land, information and programmes due to multiple social, cultural, and physical barriers. As a result, female smallholder farmers are less adaptive to rapid changes in the environment (e.g. climate change events, food price fluctuations).

Agricultural productivity in Ghana is one of the lowest in the world. Low agricultural productivity is seen as the main cause of persistently high levels of poverty in Northern Ghana. Low agricultural inputs (e.g. fertiliser, high-yield seeds), lack of irrigation and mechanisation are understood as the

main reasons for low productivity. Modernisation of agriculture with a focus of smallholder farmer is a central strategy of the government's efforts to address poverty and become an upper-middle income country by 2025.

Agricultural extension services provide information on agricultural practices and innovation to farmers with the aim of increasing productivity. Low coverage, ineffective approaches and understaffing hamper the effectiveness of public agriculture extension services in Ghana. An Information and communications technology (ICT)-based approach aim to address this gap in services, especially in remote areas.

Income diversification and up-take of non-farm economic generation activities is an effective approach to cope with uncertainty in smallholder farming. Low income remains a major challenge for subsistence farmers (with no non-farm income) and makes them vulnerable to seasonal poverty.

### ***Determinants of dietary intake in Ghana***

Child undernutrition, including micronutrient deficiencies, remains a public health concern in rural Ghana and so does the rapid emergence of overweight in adult women. Approximately 7 per cent of the population are food insecure or at constant risk of food insecurity. Dietary diversity of smallholder farmers is low, with monotonous diets based on starchy staples and very few animal-sourced foods or fruits.

Household income is a significant predictor of both food insecurity and dietary diversity, as all households in Ghana depend on food purchases (and spend around 50 per cent of their income on food). Even subsistence farmers depend on food purchases in the lean season.

Female participation in decision making regarding food purchases, livestock production, use of household income and credit are linked to more diverse diets in mothers and children. Home gardening can help to ensure all-year food security and higher dietary diversity.

### ***Mobile phone use for agriculture***

Ghana has a vibrant and highly competitive mobile phone sector and a high mobile phone penetration rate, even among very poor and poor households. Men are more likely to own a mobile phone than women in most regions of Ghana (except in Greater Accra and the Ashanti region where the reverse is the case). Nevertheless, 43 per cent of women own a mobile phone at the national level. Costs (for the handset and airtime) are the main barrier to use and ownership of a mobile phone by rural farmers.

Mobile phones are mainly used to facilitate and intensify social contacts and business interactions. The practice of sharing mobile phones and owning multiple SIM cards could prevent mobile phone-base information from reaching the intended recipients.

Mobile phones are employed to deliver agricultural extension services in Ghana and thus to help address the shortcomings of the existing services. No impact evaluation on the use of mobile phones for agricultural extension services in Ghana could be retrieved.

## **Conclusion**

The review suggests that the m-Nutrition intervention as part of Vodafone's Farmers' Club might help to address specific important needs of smallholder farmers in Ghana. More specifically, it might facilitate an increase in agricultural productivity and income through the provision of mobile

phone-based agriculture extension services. An increase in agricultural income is likely to have a positive impact on food purchases. However, the review also highlights many potential barriers to effectiveness that need to be explored further in the quantitative and qualitative baseline. These barriers include the heterogeneity of smallholder farmers and their very different information needs, the need for physical agricultural inputs (e.g. fertiliser), in addition to information, economic, social and cultural barriers to more diverse diets.

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## Abbreviations

AGRA	Alliance for Green Revolution
FAO	Food and Agriculture Organization
FASDEP	Food and Agriculture Sector Development Policy
GADD	Ghana Agro Dealer Development Project
GDP	Gross Domestic Product
ICT	Information and Communications Technology
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
MDG	Millennium Development Goals
MNO	Mobile Network Operator
MoFA	Ministry of Food and Agriculture
NGO	Non-Governmental Organisation
SMS	Short Message Service
WFP	World Food Programme
WHO	World Health Organisation
WIAD	Women in Agriculture Development Directorate

## 1 Introduction

This desk-based review forms part of the external impact evaluation of m-Nutrition in Ghana. M-Nutrition is a global initiative supported by DFID, organised by GSMA, and implemented by in-country mobile network operators (MNOs) to use mobile technology to improve the health and nutritional status of children and their mothers in the developing world. M-Nutrition is currently being implemented in eight countries in sub-Saharan Africa. In most countries, m-Nutrition is added to existing mobile phone-based platforms. A consortium of researchers from Gamos, the Institute of Development Studies (IDS) and the International Food Policy Research Institute (IFPRI) is currently conducting a rigorous mixed-methods evaluation to estimate the impact of m-Nutrition on small-scale farming households and to understand how the context and the components of the m-Nutrition intervention shape its impact.

The focus of the m-Nutrition impact evaluation in Ghana is on the m-Agriculture intervention Farmers' Club, provided by Vodafone in partnership with Esoko. Farmers' Club offers agricultural information via SMS and voice, access to an expert helpline and free calls to other Farmers' Club members. The m-Nutrition component was added on top of the existing Farmers' Club service to enable smallholder farmers to improve their nutrition – and in particular dietary diversity – alongside increasing agriculture productivity and income.

The objective of this desk-review is to inform the baseline data collection of the impact evaluation of the Farmers' Club intervention in Ghana. The focus of the review is in line with the primary outcomes of interest of the impact evaluation (i.e. to assess the impact of m-nutrition on income and productivity of smallholder farmer; and dietary diversity).

The review sets out to identify, review and summarise existing evidence on:

- a) Characteristics of smallholder agriculture in Ghana (with a specific focus on agricultural production and income);
- b) Determinants of dietary intake in rural Ghana; and
- c) The use of mobile phones for agriculture in Ghana (with a specific focus on factors that may influence up-take of mobile-based information).

### 1.1 Methods

This review was informed by targeted searches of electronic databases (Scopus, Eldis, Google Scholar and Google search engine). A search was also conducted for reports from government bodies in Ghana as well as Ghana-specific reports by the World Bank, UNICEF, Food and Agriculture Organization (FAO), the World Health Organization (WHO) and other relevant governmental and non-governmental organisations and international bodies. The focus was on evidence from the past ten years (2005–16). Key terms for the search included: “smallholder farmer”, productivity, income, “dietary diversity”, “m-agriculture services”.

## 2 Country profile of Ghana

### 2.1 Overview

The West African country of Ghana is a lower-middle income country that has a population of 27.4 million in 2015, with 46 per cent of the population living in rural areas and 54 per cent in urban areas (World Bank 2016). Ghana in 1957 was one of the first countries in sub-Saharan Africa to gain independence from UK. After independence Ghana witnessed a phase of political instability until it transitioned to multi-party democracy in 1992. Since then Ghana has been praised for its democratic system, independent judiciary and vigorous legislative activities (World Bank 2015). Ghana is ranked among the top three countries in Africa for freedom of the press and freedom of speech.

Ghana is located in sub-Saharan Africa, bordering the Gulf of Guinea in the north, and between Côte d'Ivoire in the west and Togo in the east. There are 10 administrative regions in Ghana: Western, Central, Greater Accra, Volta, Eastern, Ashanti, Brong Ahafo, Northern, Upper East, and Upper West. These are further sub-divided into 170 districts (WFP 2012). The Ashanti, Eastern and Greater Accra regions together comprise 50 per cent of the population (GSS, GHS and ICF International 2015).

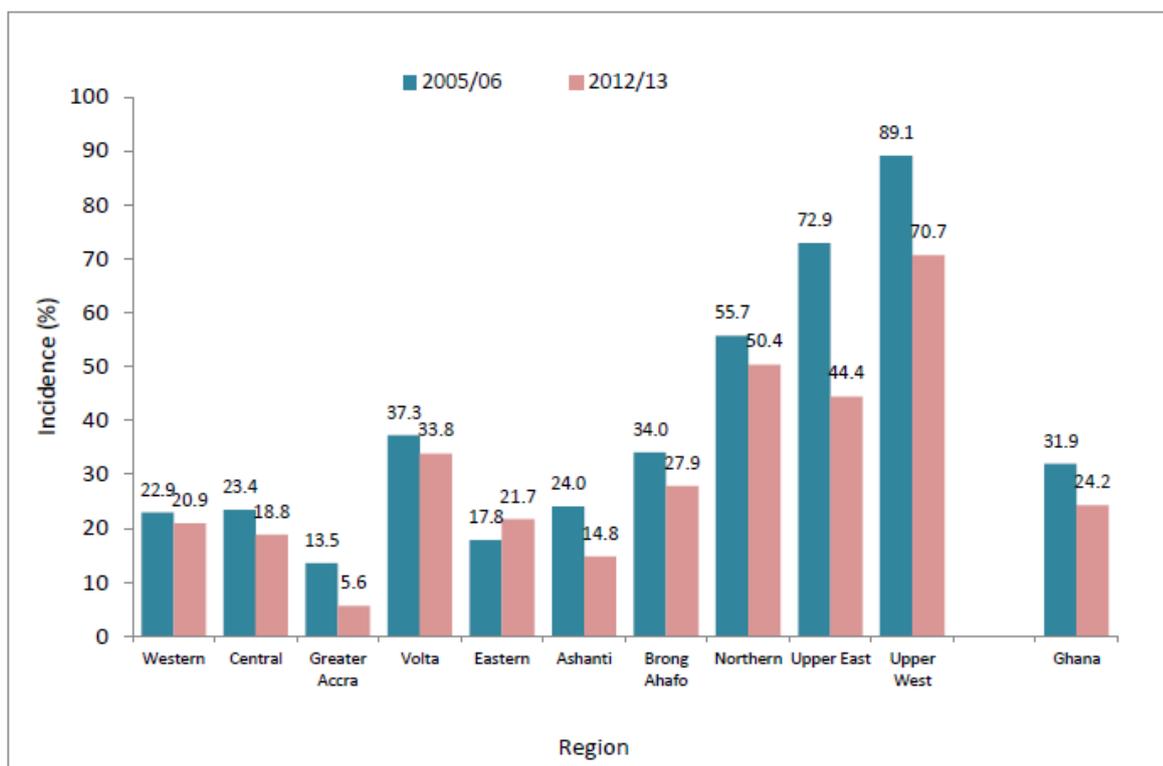
Ghana has more than seven ethnic groups, including Akan (47.5 per cent), Mole-Dagbon (16.6 per cent), Ewe (13.9 per cent), Ga-Dangme (7.4 per cent), Gurma (5.7 per cent) and several smaller ethnic groups (Langer 2010). English is the official language, though seven other languages are spoken, with Akan being the most widely spoken one. Religious affiliations include Christian (69 per cent), Muslim (15 per cent), traditional and indigenous beliefs (9 per cent) (GSS, GHS and ICF International 2015).<sup>1</sup>

Ghana has a tropical climate, which is warm and comparatively dry along the southeast coast, hot and humid in southwest, and hot and dry in the north. Droughts are frequent in the northern regions (CIA 2016).

Ghana's Human Development Index value in 2014 was 0.579, which means that the country is in a medium human development category and ranks 140th out of 188 countries (UNDP 2014). Between 1991 and 2012 poverty in Ghana fell from 52.6 per cent to 21.4 per cent based on Ghana's national poverty line, thereby achieving Millennium Development Goal 1 (MDG 1), the first sub-Saharan African country to do so (Rau 2015). Despite this dramatic overall improvement, there are huge gaps between urban and rural areas, with rural poverty now being almost four times as high as urban poverty (37.9 per cent vs 10.6 per cent based on the national poverty line) (Cooke and Hague 2016). There are also regional differences, with a pronounced north-south divide (see also Figure 2.1.1 for the regional distribution of poverty in 2005/06 and 2012/13). The Northern, Upper East and Upper West regions have the highest poverty, food insecurity and undernutrition rates, although Upper East regions saw dramatic improvements between 2006 and 2013 (Cooke and Hague, 2016).

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<sup>1</sup> The Human Development Index is a composite statistic of life expectancy, education, and income per capita indicators, which are used to rank countries into four tiers of human development.

**Figure 2.1.1: Poverty incidence by region in Ghana based on national poverty line**

Source: Ghana Statistical Service (2014)

According to the 6th Ghana Living Standards Survey farmers – in particular, self-employed smallholder farmers – are the poorest population group in Ghana and also contribute most to poverty in Ghana (Ghana Statistical Service 2014).

Other key development indicators for Ghana are outlined in Table 2.1.1.

**Table 2.1.1: Key development indicators in Ghana**

Indicator	
Population (million)	27.41
Life expectancy at birth (male/female, years)	61/64
Adult literacy rate (%)	71.5
Primary school net enrolment ratio (%)	84.3
Infant mortality rate (under one year)	49
Under-5 mortality rate (U5MR)	72
HIV prevalence (%), 15–49 years)	1.3
Economy	

<b>Population living below the national poverty line (%)</b>	28.6
<b>GDP (US\$, billion)</b>	37.86
<b>GDP growth rate (%) (2015)</b>	3.9
<b>GDP growth rate (%) (2013)</b>	7.3
<b>GNI per capita of (US\$)</b>	1,480

Sources: CIA (2016); UNICEF (2013); WHO (2015); World Bank (2016)

## 2.2 Economy

For decades, Ghana's economic development was praised as 'a model for economic growth in Africa' with good macro-economic management, a competitive business environment and sustained reductions in poverty levels, although some regional inequalities persisted with poverty, food insecurity and undernutrition remaining high in Northern Ghana (CIA 2015). In 2013, Ghana's economy experienced a dramatic downturn, with growing public deficits, high inflation and a weakening currency, resulting in its seeking a bailout from the International Monetary Fund in 2014 (BBC 2016). Since 2014 Ghana has embarked on a strict fiscal consolidation programme to address the fiscal deficits. The programme has shown some success, with the financial deficit dropping from 9.6 per cent of Gross Domestic Product (GDP) in 2014 to only 7.1 per cent, and forecast to reach 5.3 per cent in 2016 (BBC 2016). Avoiding slippage from the fiscal consolidation programme is seen as one of the main challenges for the current government during the upcoming presidential election in 2016 (BBC 2016).

Ghana's economy has long been primarily agrarian, with agriculture contributing 23 per cent of GDP in 2012 and employing about 53.6 per cent of the labour force in 2013 (FAO 2015). Cocoa is the most important agricultural export (in terms of value) contributing 30 per cent of the export revenues. Other agricultural exports are cashew, refined sugar and rubber (FAO 2015).

In recent years there has been a shift towards the growing service sector that now accounts for 48.5 per cent of the economy. The industrial sector makes up approximately 25 per cent of Ghana's GDP, mainly through the export of oil, gold, bauxite, diamonds, natural gas and electricity (CIA 2015).

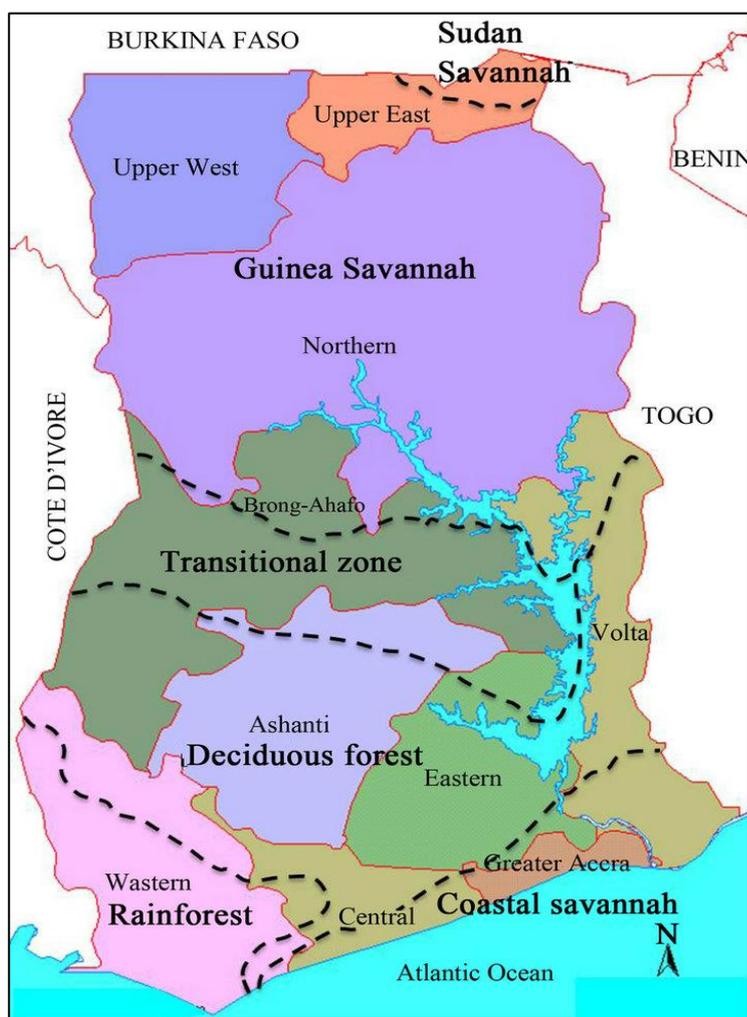
### 3 Characteristics of smallholder agriculture in Ghana

#### 3.1 Key features of Ghana's agriculture

Approximately 59 per cent of Ghana's total land area is classified as agricultural land of which 56 per cent is currently under cultivation. Most of Ghana's agriculture is rain fed and only 0.4 per cent of total agricultural land is under irrigation (based on data from 2012) (MoFA 2013). Agriculture in Ghana is pre-dominantly subsistence based, with limited use of high-yielding seed and rudimentary technology (e.g. hoe and cutlass are the main farming tools) used to produce 80 per cent of total agricultural output (FAO 2015).

Ghana has six agro-ecological zone, distinguished by natural vegetation and influenced by climate and soil characteristics: Sudan savannah, costal savannah, Guinea savannah, transition zone, semi-deciduous forest and rain forest (see Figure 3.1.1) (Choudhary and D'Alessandro 2015).

**Figure 3.1.1: The six agro-ecological zones of Ghana**



Source: Kemausuor Akowuah and Ofori (2013)

Climate and rainfall in the agro-ecological zones differ; they determine crop growth periods and also which crops are cultivated; see Table 3.1.1 for agricultural patterns by ecological zone, and Table 3.1.2 for the main crops cultivated in each zone (FAO 2005; Statistics Research and

Information Directorate 2012). Bimodal equatorial rainfall pattern allow for two annual growing seasons in the south of Ghana (i.e. rain forest, deciduous forest, transitional and coastal savannah zones). In the northern savannah (Sudan and Guinea) unimodal tropical monsoon rainfall results in a single growing season. In recent years the patterns of the major and minor rainy seasons in Ghana have become less predictable due to the effects of global warming and climate change (Owusu and Waylen 2013). The incidence of heavy rains and resulting floods as well as longer dry periods has- increased and led to loss in agricultural production.

**Table 3.1.1: Agriculture patterns in the agro-ecological zones of Ghana**

	Zones	% of total land	Mean annual rainfall (mm)	Major rainy season	Minor rainy season	Growth period in days	
						Major	Minor
South Ghana	Coastal savannah	2	600–1200	Mar–Jul	Sep–Nov	100–110	60
	Rain forest	3	800–2800	Mar–Jul	Sep–Nov	150–160	100
	Deciduous forest	28	1200–1600	Mar–Jul	Sep–Oct	150–160	90
	Transitional	3	1100–1400	Mar–Jul	Sep–Oct	200	60
North Ghana	Sudan savannah	1	800–1200	May–Sept		150–160	
	Guinea savannah	63	800–1200	May–Sept		180–200	

Source: adapted from Statistics Research and Information Directorate (2012)

**Table 3.1.2: Main crops cultivated in the different agro-ecological zones in Ghana**

Zone	Cereals	Starchy crops	Legumes	Vegetables	Tree crops
<b>High rain forest</b>	Maize, rice	Cassava, cocoyam, plantain	NA	Pepper, okra, eggplant	Citrus, coconut, oil palm, rubber
<b>Deciduous rain forest</b>	Maize, rice	Cassava, cocoyam, plantain	Cowpea	Pepper, okra, eggplant, tomato	Citrus, oil-palm, coffee, cocoa
<b>Transition</b>	Maize, rice, sorghum	Cassava, cocoyam, plantain	Cowpea, groundnut	Pepper, okra, eggplant	Citrus, coffee, cashew
<b>Coastal savannah</b>	Maize, rice	Cassava	Cowpea	Tomato, shallot	Coconut, pineapple
<b>Guinea savannah</b>	Maize, rice, sorghum, millet	Cassava, yam	Cowpea, soybean, groundnut, bambara (beans)	Tomato, pepper	Shea nuts cashew

<b>Sudan savannah</b>	Maize, rice, sorghum, millet	Sweet potato	Cowpea, soybean, groundnut, bambara	Tomato, onion	NA
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Source: adapted from Ministry of Food and Agriculture (2013)

## 3.2 Smallholder agriculture as the backbone of Ghana's agriculture

The agricultural sector in Ghana is dominated by rain-fed smallholder farming, which accounts for approximately 80 per cent of the total agriculture production. Most smallholder farmers produce a variety of crops and rely mainly on family labour; 90 per cent of all smallholder farms are 2 ha in size or less (MoFA 2013). There is no consensus on how best to define smallholder farming in Ghana and different approaches are in use; for example, based on landholding size (e.g. 1.25 ha, 2 ha, <5 ha); wealth ranking or ownership of resources; vulnerability to risks; or labour force contribution (Chamberlin 2008).

However smallholder agriculture is defined, it is important to highlight that it is very heterogeneous in Ghana and includes both highly market oriented and quasi-subsistence farming (FAO 2015). Subsistence farming dominates overall (77 per cent of all farming) and is especially prevalent in the northern regions and Greater Accra. Market-oriented smallholder farms can be found mainly in the Western region followed by Ashanti, Brong, Ahafo, Central and Eastern (FAO 2012).

### 3.2.1 Farming systems used by smallholder farmers in Ghana

Most smallholder farmers in Ghana use one of following two farming systems: bush fallow or continuous cropping (Wood 2013). Bush fallow is a rotating farming system in which vegetation from land is cleared to cultivate it for a time, then the land is left uncultivated for several years to give the soil the chance to restore fertility. Given population pressure and food demands from growing urban centres, many smallholders have shortened fallow periods drastically. As a consequence soil fertility and thus agricultural productivity have declined (Oppong-Anane 2006).

Continuous cropping is a farming system wherein cultivation is ongoing, without a fallow period. In Northern Ghana this system is also called compound system because it is closely linked to compounds or homesteads. Compound farming systems often consist of an inner zone, used for kitchen gardens for vegetables, and an outer zone, for staple cultivation and fruit trees (Kuivanen *et al.* 2016).

Within the two farming systems smallholder farmers practice either polyculture (i.e. two or more crops are cultivated on the same land; variations of these include mixed cropping or intercropping) or monoculture (i.e. only one crop is cultivated on the land) (Antwi-Agyei, Stringer and Dougill 2014).

### 3.2.2 The role of women in smallholder farming in Ghana

Women play a central role in smallholder agriculture in Ghana. They constitute half of the agriculture labour force and produce more than 70 per cent of the food.<sup>2</sup> Women also do 95 per cent of the agro-processing and 85 per cent of the food distribution (FAO 2012).

<sup>2</sup> Traditional female smallholder farmers concentrated on staple food production, whereas men cultivated cash crops. However, the boundaries are no longer clear cut.

However, female smallholder farmers have less access to agricultural resources such as land – only 9 per cent own land compared to 23 per cent of male smallholder farmers, and the land held by women is worth on average three times less than land owned by men – agricultural extension services, agrochemicals, improved seeds and other inputs (Jost *et al.* 2016). Women also benefit less from recently launched government programmes to strengthen smallholder agriculture (e.g. Youth in Agriculture programme, fertiliser subsidy programme, Agriculture Mechanization Service Centres) (Send Ghana 2014). Female smallholder farmers have limited access to agricultural credit with new ‘farmer-friendly-interest-rates’ and thus are less able to adapt to the rapid changes in the Ghanaian agriculture sector (e.g. by transforming their farms from subsistence to market-oriented production; purchasing new agricultural tools to increase productivity or buying new agro-processing equipment) (Send Ghana 2014).

Lack of access to market price information reduces female smallholders’ bargaining power in markets and further limits chances of good profits (Send Ghana 2014). Additionally, physical access to markets to sell agricultural products is difficult or impossible for many female farmers due to logistic, social and cultural barriers (FAO 2012; Send Ghana 2014).

There are multiple reasons for the limited access of female farmers to agricultural resources, including low levels of education and mobility, social and cultural barriers (FAO 2012). In Northern Ghana traditional customs also make it impossible for female farmers to receive information (e.g. about agricultural innovation or credits they might be eligible for) from outsiders (Deere *et al.* 2013; Send Ghana 2014).

The Ministry of Food and Agriculture (MoFA) has recognised the importance of female smallholder farmers and launched the Women in Agriculture Development Directorate (WIAD) situated in the ministry. WIAD has a mandate to address gender-specific issues in agriculture and implement the Gender and Agriculture Development Strategy (MoFA, 2014). Until recently, poor funding and lack of human capacity in WIAD have hampered its effectiveness in supporting the rights of female farmers (Send Ghana 2014).

### **3.2.3 Agricultural diversification: the case of the tomato**

To support and diversify livelihoods of poor smallholder farmers and reduce their vulnerability (e.g. to climatic events or food price drops), the MoFA promotes the cultivation of new agricultural products and in particular tomatoes. Tomatoes form an important part of the Ghanaians diet and the demand for them is high. In April 2010 the ministry organised a workshop on ‘Transforming agriculture: The case of the tomatoes in Ghana’. At this event international academics, donors and government officials discussed the agricultural value chain of tomatoes (IFPRI 2010).

Tomato yields remain low (e.g. due to the lack of rain and irrigation) and tomato quality is often too low for commercial agro-processing or to compete with tomatoes from neighbouring countries. Thus the full potential for tomato farming in Ghana has not yet been realised (IFPRI 2010).

## **3.3 Low productivity as the main challenge for smallholder agriculture**

Ghana’s agricultural production has grown at an average annual rate of 5.1 per cent since 1983, placing the country among the top five performers in the world (Leturque and Wiggins 2011). However, most agricultural growth has been due to land expansion and cultivation of land that previously was not used for agriculture.

Agricultural productivity has remained low; in fact, Ghana has one of the lowest agricultural yields per hectare in the world (Asmah 2011; World Bank and FAO, 2014). Even cocoa yields per hectare are far lower than in neighbouring cocoa-producing countries such as Côte d’Ivoire (FAO 2015).

Agricultural productivity is particularly poor in the north due to limited access to agricultural inputs and new technologies, and low coverage of extension services to improve practices (CIA 2015). Low productivity there has been described as one of the main causes for persistently high levels of poverty (FAO 2015).

The government of Ghana has put the increase of agricultural productivity at the centre stage to achieve the country's vision of becoming an upper-middle income country in the next decade (FAO 2015). The MoFA states its vision is of 'modernised agriculture culminating in a structurally transformed economy and evident in food security, employment opportunities and reduced poverty' (MoFA 2010). The current Agricultural Sector Development Policy (FASDEP II) aims to increase productivity through modernisation of the existing agriculture (e.g. through mechanisation, fertiliser subsidies and irrigation projects).

FASDEP II also provides a strong re-focusing on smallholder farmers as means of eliminating rural poverty and promoting economic growth (MoFA 2010). International donors' agricultural projects (e.g. the European Union, USAID, and Canada) also mainly focus on smallholder farmers, particularly in the north of Ghana.

### **3.3.1 Agricultural extension services to increase productivity**

National agriculture extension services were launched as part of the measures to increase agricultural productivity in the mid-1990s. They aim to increase farmers' skills and knowledge about best farming practices and promote agricultural innovation. The public extension services use the following approaches: training and visit, contact farmer or farmer-to-farmer, and transfer of technology approaches to extension service delivery to ensure that farmers have adequate access information for enhanced production (Bonye, Alfred and Jasaw 2012). Public agriculture extension services have been criticised repeatedly for their limited effectiveness in increasing productivity and low coverage (Adams 2012; Bonye Alfred and Jasaw 2012; Kwadzo 2014; MoFA 2002).

The MoFA has committed to a 'yearly reduction' in the extension officer: farmer ratio in an effort to strengthen public extension service delivery and address understaffing. However, the officer: farmer ratio remained 1:1500 in 2012 and 2013, suggesting that an increase in public agricultural extension services might not be a priority (Send Ghana 2014).

To address the gaps in public agricultural extension services, several other organisations offer extension services in Ghana. These comprise agriculture-related commercial companies or marketing boards such as Cotton Company Ltd, a variety of non-governmental organisations (NGOs), farmers' associations, and private agro-chemical input suppliers (Bonye, Alfred and Jasaw 2012). The m-Agriculture Farmers' Club intervention, which is focus of this impact evaluation, also aims to provide agricultural extension services using mobile phone technology. Other delivery channels for agriculture extension services are participatory farmer field schools and the provision of commodities; see Table 3.3.1 (Directorate of Agricultural Extension Services 2011).

**Table 3.3.1: Extension services and providers in Ghana**

	Categories	Characteristics	Service provider
1	Training and visit	Focus on technical aspects, regular visits to farms to provide extension service on inputs, livestock, crops, etc.	MoFA
2	Commodity	Strengthening vertical integration in value chain; usually focusing on a single crop (especially a cash crop)	Private firms
3	Participatory schools	Farmers as principal decision makers over goals, planning and development activities; extension agent to work with farmers; e.g. farmer field schools	MoFA
4	ICT-based approaches	Mobile users, online platforms; reach depends on network and affordability.	Mobile service portals, NGOs, farmer-based organisations

Source: adapted from Directorate of Agricultural Extension Services (2011)

### 3.3.2 Agricultural transition and its impact on smallholder farming

Smallholder agriculture in Ghana is in the midst of a marginal transformation (Houssou, Chapoto and Asante-Addo 2016; Houssou *et al.* 2016; Kolavalli *et al.* 2015). Rising population density, rural–urban migration and thus loss of agricultural labour force, the government’s efforts to modernise and intensify agriculture, improved road infrastructure and better access to markets (both domestic and foreign), and higher agricultural profit margins have led many subsistence smallholder farmers to transfer to market-oriented cash crop farming.

Smallholder farmers have expanded their farm sizes – which is relatively easy in Ghana due to the customary land tenure system<sup>3</sup> and availability of land – and ever more medium and even large farms are emerging (Houssou, Chapoto and Asante-Addo 2016; Houssou *et al.* 2016).

The outgrower–nucleus farmer link programme (with co-funding from the World Bank and USAID) facilitates farm expansions further by providing credits, extension advice and agricultural inputs to smallholder farmers (MoFA 2010). The programme also introduced new institutional farming arrangements for smallholder farmers such as contract farming (MoFA 2010).

## 3.4 Factors that affect the income of smallholder farmers

Smallholder farmers who have shifted from subsistence to market-oriented cash crop farming have experienced an increase in agricultural income (Ecker *et al.*, 2012). To deal with the uncertainty associated with small-scale agriculture (e.g. over climate and weather extremes, food prices, finances) more than 46 per cent of rural households in Ghana engage in complementary non-farm enterprises (e.g. hairdressing, carpentry, food processing, teaching) (Agyeman, Asuming-Brempong and Onumah 2014; Asmah 2011). Income diversification ensures steady household

<sup>3</sup> Most land in Ghana is owned by land-owning families and decisions regarding land use are made by family heads, the elderly and village chiefs.

income, addresses rural poverty and diverts the risk of food insecurity for smallholder farmers (Ecker *et al.*, 2012). Table 3.4.1 presents diversification strategies that the farming households in Northern Ghana have employed. As can be seen, strategies vary depending on households' characteristics.

**Table 3.4.1: Diversification of livelihood strategies among households in Northern Ghana**

Group	Characteristics	Assets	Activities
<b>Vulnerable</b>	High proportion of orphans, school drop-outs, youth economic migrants, widows with children, elderly, handicapped and sick	0.5 acres; no livestock; basic house, cooking equipment and clothing	Sale of firewood, making baskets and ropes, shea nut gathering, buying/selling foodstuffs
<b>Poor</b>	Widows with children, semi-migrants, migrants with farms outside their tribal area, small-scale farmers with weak labour capacities	0.3–2.5 acres; some cattle; bicycle and roofing sheets	Food crops and livestock farming, seasonal and semi-permanent migration; petty trading
<b>Medium</b>	Large family and high labour capacity	1.5–4 acres per member; sizeable number of cattle; permanent house; modest education and household equipment.	Farm and non-farm activities
<b>Well-off</b>	Large family and high labour capacity; higher proportion of skilled labour	1–25 acres per member, large cattle; permanent housing with facilities.	Agricultural: perennial (cocoa, rubber, mango); food crops on commercial scale; non-agri work.

Source: adapted from Al-Hassan and Poulton (2009)

Low agricultural income remains a pressing issue for poor subsistence farmers and especially for those who have not embarked on any off-farm economic activities (Ecker *et al.* 2012). Subsistence farmers who focus on staple crop cultivation without any agricultural diversification are particularly vulnerable and often have poor diets and high levels of undernutrition (Ecker *et al.* 2012). Poor storage and post-harvest management of agricultural products often result in damage and loss of a proportion of the harvest, and have further negative effects on household income (GAIN 2012).

### 3.5 Implications for the m-Agriculture impact evaluation

The m-Agriculture intervention, Farmers' Club, provides information to smallholder farmers on how to increase agriculture productivity and income. Section 3 of this review has described key features and challenges of agriculture in Ghana. Many of the identified features and factors may interact, facilitate or hinder the up-take of the information provided by m-Agriculture and may help to explain why, under which circumstances and for whom the intervention was successful in improving agriculture productivity and income. Both the qualitative and the quantitative evaluation streams will collect data on factors that may interact with the up-take of the information and the translation of the information into action.

For example, the review has highlighted that the majority of smallholder agriculture in Ghana is rain-fed and that irrigation systems are rare. In this context, the weekly weather information

provided by the m-Agriculture intervention may be particularly relevant to inform planting or harvesting decisions making by farmers. The qualitative midline aims to explore farmers' perceptions of the usefulness and relevance of the regular weather messages and will document farmers' action in response to the messages. The quantitative surveys will collect information on the up-take of the features and will also collect data weather conditions during the intervention period.

Section 3 has described the heterogeneity among smallholder farmers in Ghana including subsistence or market-oriented farming, compound farming or bush fallow farming systems, polyculture or monoculture. In the initial sign-up to Farmers Club, farmers are profiled depending on their specific farming system and personal preferences (e.g. for crops cultivated). The farmers then receive information tailored to their specific profiles. Both the qualitative and quantitative evaluation streams will reflect on the diversity among smallholder farming in Ghana and will explore the effectiveness, perceived usefulness and relevance of the tailored messages among the different sub-groups of farmers.

The evaluation will specifically focus on examining the impact of m-Agriculture intervention on female farmers who have been traditionally excluded from agriculture extension services and inputs in Ghana. The qualitative baseline and midline will explore barriers and facilitators for the up-take of the messages and behaviour change in response to the messages among female farmers. The quantitative sample selected a sub-sample of female farmers to examine the impact of m-Agriculture on their agricultural productivity and income.

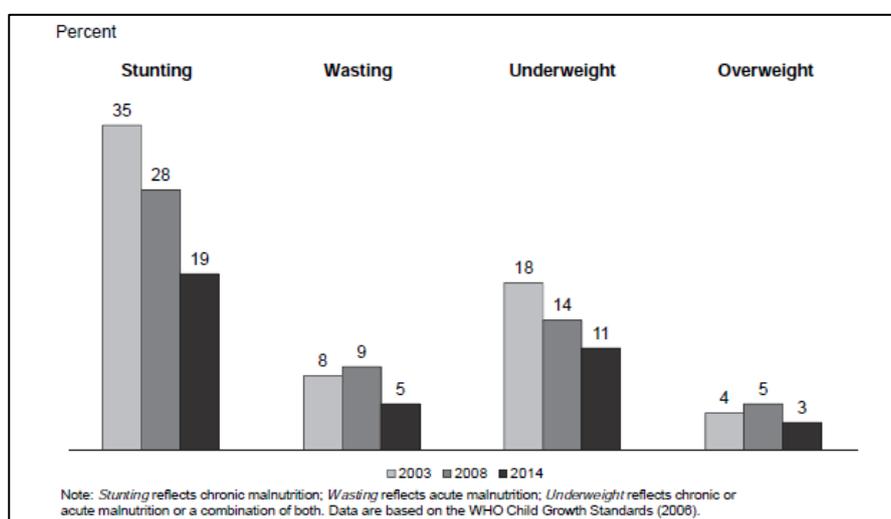
The review has stressed the short-comings of agriculture extension services in Ghana. The qualitative and quantitative evaluation streams aim to assess whether the m-Agriculture has the potential to fill the existing gap in service delivery.

## 4 Determinants of dietary intake in rural areas of Ghana

### 4.1 Nutritional status of the rural population

Child undernutrition remains a challenge in Ghana, despite a steady decline since 2003 (see Figure 4.1.1) (DHS *et al.* 2015). In 2014, 19 per cent of children aged below five years were stunted (low height for their age) and 5 per cent per cent were wasted (low weight for their height) (DHS *et al.*, 2015). Children in rural areas were more likely to be stunted than their urban counterparts (22 per cent vs 15 per cent). There were also some considerable regional differences in child undernutrition, with children with children in Northern Ghana being most likely to be stunted (33 per cent of all children). ‘Hidden hunger’ due to micronutrient deficiencies was also significantly more common in the rural northern parts of Ghana (DHS *et al.* 2015).

**Figure 4.1.1: Nutritional status in Children in Ghana in 2003, 2008 and 2013**



Source: DHS *et al.* (2015)

Undernutrition in adult women is more common in rural than in urban areas (7.4 per cent vs 5.2 per cent of women aged 15–49 years), with the highest prevalence of female thinness found in Northern Ghana (DHS *et al.* 2015). In parallel, overweight and obesity have become very common, with almost one-third of women in rural areas and almost half of all women in urban areas being categorised as overweight or obese (DHS *et al.* 2015).

### 4.2 Determinants of dietary intake

A diverse diet with sufficient quantities of nutritious food is important for healthy growth and development of children and to meet nutritional demands during pregnancy and lactation. The UNICEF framework for the causes of undernutrition – the guiding framework for nutrition programming over the past 25 years – highlights insufficient dietary intake as an immediate cause for undernutrition, and household food insecurity as an underlying one (UNICEF 1990). Dietary intake is also a key determinate for the prevention and treatment of overweight and obesity (Swinburn *et al.* 2004). In the following, existing evidence on determinants of dietary diversity and food security in rural Ghana will be presented.

### **4.2.1 Food insecurity is common**

Food insecurity is complex and depends on food availability, access, utilisation and stability. In Ghana it is estimated that currently 5 per cent of the population are food insecure and 2 per cent are at risk of food insecurity (Darfour and Rosentrater 2016). Smallholder farmers in North Ghana are those most affected by food insecurity (Hesselberg and Yaro 2006).

#### ***Barriers and enablers of food security in Ghana***

Higher household income has been positively associated with food security in Ghana. In particular, smallholder households that have diversified their income sources and have additional non-farm income streams are more food secure and less vulnerable to shocks (Owusu, Abdulai and Abdul-Rahman 2011). Independent of whether a farmer focuses on subsistence or market-oriented agriculture, he/she needs to purchase at least some of the food the household consumes (GAIN 2012). A household that, for example, produces maize still needs to buy in maize for consumption during the lean period.

Food price shocks have been shown to negatively affect access to and consumption of food, especially because households already spend half of their income on food (Cudjoe, Breisinger and Diao 2010). Home gardening has been successful in improving food security all year round, especially for households affected by HIV/Aids (Akrofi *et al.* 2010; GAIN 2012; Laar and Aryeetey 2014).

Climatic events (e.g. droughts, floods) as well as seasonal changes are a major cause for household food insecurity in Ghana. Smallholder farmers often have low financial capacities and knowledge about how to adapt to these events promptly (WFP 2016).

### **4.2.2 Dietary diversity**

The Ghana Demographic and Health Survey 2014 shows that only 21 per cent of breastfed children aged between 6 and 23s and living in rural areas met the recommended levels of dietary diversity (four food groups or more a day) (DHS *et al.* 2015). There are also dramatic regional differences, with children in Eastern Ghana being least likely to meet the recommended levels (only 4 per cent of children) (DHS *et al.*, 2015). Dietary diversity of females is equally low (DHS *et al.* 2015).

Diets of rural smallholder farmers in Ghana are often monotonous and dominated by starchy staple foods (e.g. cassava, yams, plantains, maize or rice, depending on region) as the main supplier of dietary energy. Animal-sourced foods and fruits are consumed infrequently (FAO 2010; Zakaria and Laribick 2014).

#### ***Barriers and enablers of diverse diets in rural Ghana***

Household income has been identified as a key determinant of a households' food-purchasing power, and thus influences what kinds of food a household can access and consume (Amugsi, Mittelmark and Lartey 2014; Colecraft *et al.* 2006; Zakaria and Laribick 2014). Dietary diversity significantly improved with increased household income, especially if income was augmented by non-farm income (Ecker *et al.* 2012).

Female empowerment and in particular women's' participation in decision making regarding livestock production, food purchasing, use of and control over household income and access to credits has been shown to be significantly associated with dietary diversity in several studies (Amugsi *et al.* 2016; Colecraft *et al.* 2006; Laar and Aryeetey 2014; Zakaria and Laribick 2014).

Dietary diversity of women in Ghana is influenced by different socio-cultural factors. For example, in some communities women always eat after men, and also animal-sourced (nutrient-rich) food is mainly served to men (Colecraft *et al.* 2006). Women often receive less food in intra-household food distribution and also are more likely to sacrifice meals for their children in times of food scarcity (Laar and Aryeetey 2014).

Dietary diversity among smallholder farmers with home or kitchen gardens, and/or who are engaged in small livestock rearing, is often higher, suggesting that households consume at least a part of these agricultural products rather than selling them (Akrofi *et al.* 2010; Bagson and Naamwintome Beyuo 2012; Ecker *et al.* 2012; Yiridoe and Anchirinah 2005). The number of food groups produced by smallholder farmers has also been shown to have a positive effect on dietary diversity (Ecker *et al.* 2012).

Household size and structure, age, marital status, education and food preferences also influence dietary diversity in Ghana (Pollack 2001; Ruel, Deitchler and Arimond 2010; Zakaria and Laribick 2014).

Food taboos among different ethnic groups also reduce dietary diversity among women in rural Ghana (see table 4.2.1).

**Table 4.2.1: Ethnicity-specific food taboos in Ghana**

<b>Food taboo</b>	<b>Belief system/ reason for adherence</b>	<b>Ethnicity/ religion</b>	<b>Main nutrient</b>
<b>Banana</b>	Causes premature contractions during pregnancy	Ga's	Vitamins and minerals
<b>Okra</b>	Reduces men's sexual stamina, making them weak during battles	Mole-Dagbone	Vitamins and minerals
<b>Yam</b>	Water yam causes boils; new yam should be offered to gods before it is consumed	Akans, Ga's Peki (Ewes)	Carbohydrate
<b>Ripe plantain</b>	Causes miscarriage during pregnancy	Akans	Carbohydrate, proteins
<b>Beans</b>	Certain people are instructed by gods against consumption; causes stomach disorders	Akans	Carbohydrate, proteins
<b>Kuka (baobab leaves)</b>	Causes marks on skin	Grusis	Vitamins
<b>Fufu (pounded cassava, yam, plantain)</b>	Forbidden for widows to eat	Akans	Carbohydrate
<b>Pineapple</b>	Causes miscarriage	Akans (Fante)	Vitamins
<b>Cocoyam</b>	Consumption of certain species affects men's sexual performance	Akyam Akans	Carbohydrate

<b>Guava</b>	Causes appendicitis	Akans, Ga's Ewes	Vitamins and minerals
<b>Fresh meat</b>	Dries up milk of lactating mothers and causes post-partum diarrhoea	Ewes Gas	Protein

Source: adapted from GAIN (2012)

### 4.3 Implications for the m-Agriculture impact evaluation

The m-Agriculture intervention provides nutrition information with the aim of increasing the dietary diversity of smallholder farmers. Section 4 has highlighted several socio-economic and cultural barriers to and facilitators of diverse diets among smallholder farmers in Ghana. These factors may facilitate or prevent the up-take of the m-Agriculture nutrition messages and may explain potential behaviour change or lack thereof. For example, food security remains a pressing challenge in Ghana, and non-availability or accessibility of food (due to seasonal shortages, climate shocks, lack of income to purchase food) has been shown to limit the diet composition of people. In this context, behaviour change messages tailored at increasing dietary diversity might be impossible to follow. Both the qualitative and quantitative evaluation streams will collect data on smallholder farmers' experiences with food insecurity, coping strategies and consequences on dietary diversity.

The m-Agriculture product promotes the cultivation and consumption of nutrient rich crops. The review has highlighted several factors that may influence whether farmers (and their children) will actually consume these crops (e.g. food preferences, cultural practices, available household income, and female empowerment). Both the quantitative and qualitative evaluation streams will collect information on household decision-making processes with regards to food consumption and will examine whether farmers cultivated and consumed the promoted crops (or why not).

## 5 Mobile phones for agriculture in Ghana

### 5.1 Mobile phone technology in Ghana

Ghana has one of the most vibrant mobile phone sectors in Africa. According to data from the National Communications Authority of Ghana, there were a total of 36.4m voice mobile phone subscriptions in April 2016, which accounts for a mobile phone penetration rate of 132 per cent (National Communications Authority 2016). Many Ghanaians own two or more SIM cards and have several subscriptions. The unique subscriber penetration is therefore lower (approximately 50 per cent, based on data from GSMA) (Oxford Business Group 2015).

There are several competing mobile phone network operators (MNOs) in Ghana. The competition has resulted in an lower than average revenue per user and also brought down call costs dramatically to average call costs of 0.09 cedi (\$0.02) per minute (the lowest call costs in Africa) (Budde 2015; Oxford Business Group 2015). Table 5.1.1 presents the market shares of the different MNOs in Ghana. Most mobile subscription are currently with Scancom (MTN) (47 per cent), followed by GT/Vodafone (22 per cent), Millicom (Tigo) (14 per cent), Airtel (14 per cent) and others (National Communications Authority 2016).

**Table 5.1.1: Mobile voice market shares (April 2016) in Ghana**

Mobile network operators	% share
Glo Mobile	3
Expresso	0.30
Millicom/Tigo	14
Scancom/MTN	47
GT/Vodafone	22
Airtel-Mobile	14

Source: National Communications Authority (2016)

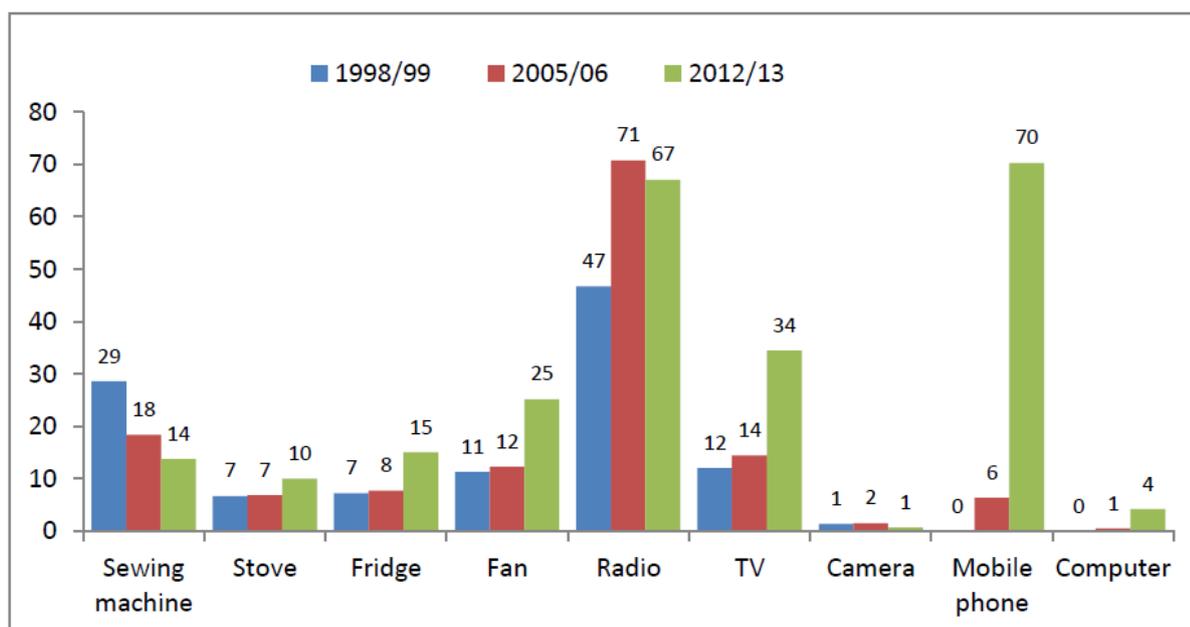
Pre-paid<sup>4</sup> mobile phone contracts are the most popular in Ghana, accounting for 97 per cent of all subscriptions (World Bank 2014).

### 5.2 Access to mobile phones for poor households

Mobile phone ownership is high in Ghana, with almost 90 per cent of urban households and 70 per cent of rural households owning a mobile phone in 2012/13 (Ghana Statistical Service 2014). In rural areas households are now more likely to own a mobile phone than they are to own a TV or radio (see Figure 5.2.1) (Ghana Statistical Service 2014). Even in very poor and poor rural households mobile phone ownership is high, at 50 per cent and 64 per cent respectively (Ghana Statistical Service 2014). Most mobile phones in rural areas are simple cell phones, whereas smartphone ownership is more common in urban areas (PEW Research Centre 2015).

**Figure 5.2.1: Asset ownership of rural households in Ghana in 1998/9, 2005/6 and 2012/13**

<sup>4</sup> Pre-paid phones require customers to top up their account balance with a cash payment when credit is used up or expires. Credit can be used for various services including voice calls, SMS (text) messages, and mobile internet.



Source: Ghana Statistical Service (2014)

Men are more likely to own a mobile phone than women (53 per cent male ownership vs 43 per cent female ownership) (Ghana Statistical Service 2013). There are also some regional differences in gender-based mobile ownership. In Greater Accra and the Ashanti region more women than men own mobile phones (Ghana Statistical Service 2013). This might be explained by the higher proportion of women who work in the informal sector in these regions and have started to rely on mobile phones for their business transactions (Ghana Statistical Service 2013). In other regions of Ghana the percentage of female ownership is lower than male ownership, with women in Northern, Upper West and Upper East regions being least likely to own a mobile phone.

### 5.2.1 Barriers to the use of mobile phone technology

Affordability is the key barrier to mobile phone ownership and use in Ghana, especially for poor rural households (World Bank 2014). In 2013, the Ministry of Finance re-imposed a mobile phone tax of 20 per cent import duty tax on all handsets. Following the reintroduction of the tax there was a drop in mobile phone sales. In 2015, the Ministry of Finance cancelled the tax to promote greater digital inclusion of the entire population. However, the cancellation has not been actively enforced by the government and press coverage on the cancellation has been patchy (Quist 2016). The Ministry of Finance also introduced the Communication Service Tax on mobile data and all mobile services, which increased user costs (Ling and Horst 2011).

To mitigate some of the mobile phone costs users employ different strategies including shared phones, missed calls (to trigger a call back) and late night calls (at a cheaper tariff). There is also an increasing trend of using multiple SIM cards to make use of different packages and offers (Oxford Business Group 2015).

### 5.2.2 Mobile phones as a source of information in rural Ghana

ICT-based approaches for the delivery of information to rural communities have become increasingly popular due to their low communication costs and far reach (Hoq 2014).

In Ghana mobile phones are used mainly for voice calls and SMS messages. Even if a mobile phone is capable of browsing the internet only 11 per cent use this feature (mainly in urban areas) (World Bank 2014). Mobile phones are valued because they facilitate faster connectivity with

friends and family, and thus intensify social networks and social interaction; but mobiles usually do not establish new social contacts as social media would do (Ling and Horst 2011).

Mobile phones also play an important role in business in Ghana by facilitating connections between sellers and buyers, thereby creating more efficient markets (Bornman 2012; Sey 2011).

The common practice of phone sharing in Ghana could mean that information delivered via a mobile phone does not reach the owner of the phone, but someone else who shares the phone with the owner (Bornman 2012). This may hamper the effectiveness of mobile phone-based information services. Similarly, the practice of multiple SIM card ownership might prevent mobile phone-based information from reaching the intended recipient.

### 5.3 Mobile phones for agriculture in Ghana

In the agricultural sector in Ghana mobile phone technology has mainly been employed as a delivery channel for agricultural extension services to farmers (Aker and Fafchamps 2010). As highlighted in section 3.3.1 public agriculture extension services in Ghana have been criticised for their limited scale and lack of effectiveness in improving agricultural knowledge, practices and productivity. Mobile phone-based extension services aim to address these shortcomings (Directorate of Agricultural Extension Services 2011). Table 5.3.1 lists existing m-Agriculture platforms in Ghana.

**Table 5.3.1: M-Agriculture platforms in Ghana**

Projects	Purpose	Operators and partners	Key lessons/ impact <sup>5</sup>
<b>TIPCEE–Trade and Investment Programme for Competitive Export Economy (does not exist anymore)</b>	Assisted mango and citrus fruits growers with GIS mapping, disease and pest control training, information about harvesting techniques. Developed mobile content to improve data collection from farmers	Funded by USAID, in partnership with MTN	Enabled collection of real-time on-farm data, which were then relayed to buyers to provide advice on scout information (Debrah and Asare, 2013)
<b>GADD–Ghana Agro Dealer Development Project (2009)</b>	Developed SMS and online application to link seed producers to agro-input dealers	Funded by Alliance for Green Revolution (AGRA), which is funded by the Bill & Melinda Gates Foundation and has various collaborative programmes with donors on linking farmers with the value chain (AGRA, 2016)	In 2010 seed company GADD carried out a mass messaging to 1,000 agro-input dealers; more than 700 dealers received those messages and concluded business with the company. As a result, GADD opened more distribution points to serve Northern Volta, Southern Volta and Eastern regions; farmers could access high-quality seeds

<sup>5</sup> Where studies were available.

			from dealers, with shortened search and discovery time (Debrah and Asare 2013)
<b>Mfarms</b>	Online and cell phone-based platform to link agricultural actors in the value chain processes for different agricultural products; assists in the Farmer to Market project funded by AGRA; actors can also interact among themselves through the use of SMS services and interactive voice-responsive services (Tamale 2012)	In partnership with Ghana Agricultural Associations Business and Information Centre; Image AD-Ghana helped in the development of the ICT tool (IFDC 2012)	NA
<b>CocoaLink</b>	The Hershey Company and the World Cocoa Foundation created this programme to provide free voice and SMS text messages about farm safety, child labour, health, and improvements in farming practices, crop disease prevention and crop marketing. Farmers receive messages in English or their local language (Schneider 2015)	Any network	Delivered 100,000 messages; 3,720 registered subscribers, of whom 95% are cocoa farmers; and 40% of registered users attended community trainings (World Cocoa Foundation 2013)
<b>Akuafu Nkouso (2015)</b>	Farmers can buy agricultural inputs on credit and also access credit for farm improvement. Farmers can buy agrochemical products from shops registered on the platform and pay for the inputs when they harvest the produce. Operates via farmer-based organisations (Andoh, 2015)	Airtel and Zeepay, a mobile payment money application	Programme currently being piloted in the Ashanti region. Aim is to develop a cashless ecosystem where farmers can pay for services using the platform. Only available to Airtel-Zeepay platform customers (Andoh 2015; Sam 2016))
<b>Tradenet (launched in 2004, renamed Esoko in 2009)</b>	<p>Provided timely market price information for different staple crops, tips on post-harvest management and marketing</p> <p>Users signed up for SMS alerts to receive instant alerts on buying and selling commodities in different markets of their choice; can receive real time prices for over 80 commodities from 400 markets across West Africa (Farming First 2009)</p>	Funded by USAID (MISTOWA project)	Lessons drawn from several initiatives since 2004: prices available via SMS showed moderate gains in the commodity market in Ghana; technology facilitated speedy dissemination of market information prices, volumes, road condition etc.; Esoko SMS services found a

<p><b>Farmer Helpline in 2014</b></p>	<p>Call centre facility to advise farmers on diseases, pests, post-harvest issues, storage and other agricultural information (details also provided in section 5.3.1)</p>	<p>Esoko in partnership with USAID; call rates on Vodafone, MTN and Airtel (Acheampong, 2014)</p>	<p>10% increase in crop prices farmers in the treatment group receives (Debrah and Asare 2013; Egyir, Al-Hassan and Abakah 2011; Subervie 2011)</p> <p>Farmers seek information for the following purposes: 48% for agricultural advice; 32% for weather forecasts; 17% for market prices; 2% for technical support; 1% for offers to buy and sell (Esoko 2014).</p>
<p><b>Farmerline (piloted 2013)</b></p>	<p>Three service lines: 1) outbound messaging, which provides personalised voice alerts related to information on price, weather and farming techniques; 2) mobile surveys that allow farmer-based organisations to conduct surveys and capture the impact of their intervention; and 3) access to expert advice (Nagasaki 2014)</p> <p>Has a large proportion of female customers (Nagasaki 2014). Launched the Women Advancing Agriculture initiative, which sends voice messages directly to the mobiles of female agricultural workers, providing information on agronomy, weather forecasts, market prices, maternal health and financial literacy (Farmerline 2015)</p>	<p>Not known</p>	<p>Lessons learnt from a first small pilot study funded by Indigo Trust: results of evaluation of agronomy tips to fish farmers in Ashanti region (2012): 6% increase in the weight of fish; 44% increase in the selling price; 2% decrease in the harvesting time of fish; and 40% increases in the income of farmers (Committee on World Food Security 2012).</p>

### 5.3.1 Vodafone's Farmers' Club

Launched in 2015 by Vodafone, this service has specially designed voice and text packages containing information on nutrition, weather information and market prices. The nutrition content was rolled out in November 2015. The bundle targets eight regions: Eastern, Western, Ashanti, Central, Northern, Volta, Brong-Ahafo and Greater Accra. The service provides free calls between members of the Farmers' Club, competitive call rates and access to an expert helpline (Vodafone 2015). Following its launch, the service was aggressively marketed via a strategic trading centre in the North and South regions, followed by a less aggressive marketing campaign that involved a

range of 'permanent agents', who enrol the customers. These include ambassadors (one per district), retail agents, community shops and input dealers.

Vodafone has partnered with Esoko to provide these services. Esoko already had an established network whereby personal mobile users used the services to connect to end users, traders, suppliers, extension services and with each other (Duncombe 2012). Esoko has representatives who visit about 50 different markets in the various regions each day and compile the going price of foods. This information is then relayed to Esoko headquarters, where it is packaged into simple and comprehensive SMS messages and sent to the farmers who are subscribed on the platform. NGOs such as the Advance Project covered the costs for Esoko to provide information subscribers. The information received by farmers is then communicated to others, and farmers are able to write and read and trained in digital technology for this purpose. While some farmers display information on notice boards where they meet for weekly meetings, some are organised into cooperatives, which facilitates distribution of information (Esoko 2015). For expert advice or voice-based calls, farmers can access the helpline by dialling a short code (1900) at their regular call rate. The agricultural experts can give them answers on diseases and pests, post-harvest issues, storage, use of pesticides, fertilisers and more on 10 commodities in 12 local languages (Esoko 2014). Farmers in northern Ghana in particular know and trust Esoko.<sup>6</sup>

Farmers' Club is currently marketed by Vodafone agents. Vodafone works with two agencies (one for the North of Ghana and one for the South) to promote the product. While the agencies differ in their approach, the main aim of the agents is to sell as many Farmers' Club SIM cards as possible. Agents are paid on the basis of the number of sales they have made. If they do not reach a minimum number of sales per month, they are not paid. Agents are supposed to sign farmers up for the SIM card and then register them for Farmers' Club. The registration takes long as farmers have to specify the crops they are interested in, days when they would like to receive information, etc. The Esoko call centre follows up with the farmers and completes the registration.<sup>7</sup>

The Farmers' Club service provides information via SMS in English only and in Voice SMS in 13 local languages. Farmers get weather information (3 times a week), price information (1–2 times a week), general nutrition information that mainly focuses on dietary diversity (4 messages per month). Farmers are encouraged to call the call centre (free of charge) to discuss and ask questions about the content of the messages. The call centre staff are trained on the content and can answer questions about agriculture and nutrition.

## 5.4 Implications for m-Agriculture impact evaluation

Section 5 has highlighted several barriers to the access and use of mobile phones in Ghana and also described common practices of mobile phone use (e.g. shared mobile phones, ownership of multiple sim cards). All of these factors potential may hamper the successful up-take of the m-Agriculture information and need to be carefully monitored in both the qualitative and quantitative evaluation streams. Other factors such as network accessibility, access to electricity and language barriers may reduce the up-take and will be assessed at baseline and endline. Competing m-services, and their potential effect on m-Agriculture will be captured in the business and quantitative components of the evaluation.

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<sup>6</sup> Information based on preliminary team visit to Ghana in February 2016.

<sup>7</sup> *Ibid.*

## 6 Conclusion

In line with the aims of the impact evaluation of m-Nutrition, this review aims to summarise evidence on: 1) smallholder agriculture in Ghana; 2) determinants of dietary intake; and 3) the use of mobile phone technology for agriculture in Ghana.

### 1. Smallholder agriculture in Ghana

- Agriculture in Ghana relies on smallholder farmers who make up 80 per cent of agricultural production.
- Smallholder agriculture is mainly subsistence farming, rain fed, based on rudimentary technology and with low or no agricultural input (e.g. fertiliser, technology).
- Smallholder farmers are a heterogeneous group (e.g. in terms of whether they are subsistence or market-oriented production, have a female- or male-headed farm, the choice of farming system employed, the agro-ecological zone they are located in, crops cultivated, whether they have a non-farm income, whether they are in the process of transformation and farm expansion, etc.). The needs (including information needs) of each smallholder farmer group differ.
- Women play a central role in smallholder farming, but have limited access to agricultural resources and information. Consequently, they are often less adaptable to change.
- Low agricultural productivity is a major challenge due to low agricultural inputs, limited irrigation and low mechanisation.
- Public agricultural extension services are often ineffective, understaffed and have low coverage (especially in northern Ghana). ICT-based extension services seek to address shortcomings in existing public services.
- Income diversification through non-farm economic activities is an effective strategy to increase income and cope with uncertainty.
- Low and variable income remains a major problem for subsistence farmers and makes them vulnerable to shocks.

### 2. Determinants of dietary intake

- Smallholder farmers are especially vulnerable to food insecurity and low dietary diversity.
- Household income is a significant determinant of food security and dietary diversity, because households spend 50% or more of their total income on food.
- Home gardening has been shown to increase -year-round food security and diets.
- Female participation in decision making regarding food purchases, food production, use of income and credits is key to diverse diets for mothers and children.

### **3. Mobile phones for agriculture**

- Ghana has a vibrant mobile phone sector and high mobile phone penetration, even among poor rural households and women
- Costs remain the main barrier to mobile phone ownership and use.
- Mobile phones are valued because they facilitate social contacts and mediate business connections
- The common practice of sharing mobile phones and changing SIM cards might prevent mobile phone-based information from reaching intended recipients.
- Mobile phones are used to deliver agricultural extension services in Ghana, but so far no impact evaluation of this service exists

## References

- Acheampong, J. (2014) *Graphic Business-Ghana*, [www.graphic.com.gh/business/business-news/esoko-introduces-ghana-s-first-farmer-helpline.html](http://www.graphic.com.gh/business/business-news/esoko-introduces-ghana-s-first-farmer-helpline.html) (accessed 23 February 2016)
- Adams, M.N. (2012) 'Performance of non-governmental organisations in agricultural extension service delivery in the Upper West region of Ghana', unpublished M.Phil thesis, University of Cape Coast
- AGRA (2016) *How we work: Alliance for Green Revolution in Africa*, [www.gatesfoundation.org/How-We-Work/Resources/Grantee-Profiles/Grantee-Profile-Alliance-for-a-Green-Revolution-in-Africa-AGRA](http://www.gatesfoundation.org/How-We-Work/Resources/Grantee-Profiles/Grantee-Profile-Alliance-for-a-Green-Revolution-in-Africa-AGRA) (accessed 26 June 2016)
- Agyeman, B.A.S., Asuming-Brempong, S. and Onumah, E.E. (2014) 'Determinants of Income Diversification of Farm Households in the Western Region of Ghana', *Quarterly Journal of International Agriculture*, 53(1), 55–72
- Aker, J.C. and Fafchamps, M. (2010) How does mobile phone coverage affect farm-gate prices? Evidence from West Africa. [www.aeaweb.org/aea/2011conference/program/retrieve.php](http://www.aeaweb.org/aea/2011conference/program/retrieve.php) (accessed 26 June 2016)
- Akrofi, S., Brouwer, I.D., Price, L.L. and Struik, P.C. (2010) 'Home gardens contribute significantly to dietary diversity in HIV/AIDS afflicted households in rural Ghana', *Journal of Human Ecology*, 31(2), 125–34
- Al-Hassan, R. and Poulton, C. (2009) 'Agriculture and social protection in Ghana', *FAC Working Paper No. SP04*, Future Agricultures Consortium
- Amugsi, D.A., Lartey, A., Kimani, E. and Mberu, B.U. (2016) 'Women's participation in household decision-making and higher dietary diversity: findings from nationally representative data from Ghana', *Journal of Health, Population and Nutrition*, 35(1), 1–8
- Amugsi, D.A., Mittelmark, M.B. and Lartey, A. (2014) 'Dietary diversity is a predictor of acute malnutrition in rural but not in urban settings: evidence from Ghana', *British Journal of Medicine and Medical Research*, 4(25), 4,310
- Andoh, D. (2015) 'Agric attracts telcos' attention', *B&FT Online*, 16 December, <http://thebftonline.com/business/agribusiness/16513/agric-attracts-telcos-attention.html> (accessed 21 April 2016)
- Antwi-Agyei, P., Stringer, L.C. and Dougill, A.J. (2014) 'Livelihood adaptations to climate variability: insights from farming households in Ghana', *Regional environmental change*, 14(4), 1,615–26
- Asmah, E.E. (2011) 'Rural livelihood diversification and agricultural household welfare in Ghana', *Journal of Development and Agricultural Economics*, 3(7), 325–34
- Bagson, E. and Naamwintome Beyuo, A. (2012) 'Home Gardening: The Surviving Food Security Strategy in the Nandom Traditional Area-Upper West Region Ghana', *Journal of Sustainable Development in Africa*, 14(1) (accessed 24 June 2016)
- BBC (2016) Ghana Country profile, [www.bbc.co.uk/news/world-africa-13433790](http://www.bbc.co.uk/news/world-africa-13433790) (accessed 26 July 2016)

- Bonye, S.Z., Alfred, K.B. and Jasaw, G. S. (2012) 'Promoting Community-Based Extension Agents as an Alternative Approach to Formal Agricultural Extension Service Delivery in Northern Ghana', *Asian Journal of Agriculture and Rural Development*, 2(1), 76–95
- Bornman, E. (2012) 'The mobile phone in Africa: Has it become a highway to the information society or not?', *Contemporary Educational Technology*, 3(4), 278–92
- Budde (2015) *Ghana – Mobile Infrastructure, Operators and Broadband – Statistics and Analyses*, [www.budde.com.au/Research/Ghana-Mobile-Infrastructure-Operators-and-Broadband-Statistics-and-Analyses.html](http://www.budde.com.au/Research/Ghana-Mobile-Infrastructure-Operators-and-Broadband-Statistics-and-Analyses.html) (accessed 25 July 2016)
- Chamberlin, J. (2008) 'It's Small World After All: Defining Smallholder Agriculture in Ghana', Vol. 823, Washington DC: IFPRI
- Choudhary, V. and D'Alessandro, S. (2015) *Ghana Agricultural Sector Risk Assessment*. Washington DC: World Bank
- CIA (2016) *The World Factbook: Ghana*, [www.cia.gov/library/publications/the-world-factbook/geos/gh.html](http://www.cia.gov/library/publications/the-world-factbook/geos/gh.html) (accessed 19/07/2016)
- CIA (2015) *Overview Ghana*, [www.cia.gov/library/publications/the-world-factbook/geos/gh.html](http://www.cia.gov/library/publications/the-world-factbook/geos/gh.html) (accessed 24 July 2016)
- Colecraft, E., Marquis, G.S., Aryeetey, R., Sakyi-Dawson, O., Lartey, A., Ahunu, B., Huff-Lonergan, E. (2006) 'Constraints on the Use of Animal Source Foods for Young Children in Ghana: A Participatory Rapid Appraisal Approach', *Ecology of Food and Nutrition*, 45(5), 351–77
- Committee on World Food Security (2012) *Developing the knowledge, skills and talent of youth to further food security and nutrition*, [www.fao.org/fileadmin/templates/cfs/Docs1415/Events/youth/casestudies/CFS42\\_Youth\\_Africa\\_Farmerline.pdf](http://www.fao.org/fileadmin/templates/cfs/Docs1415/Events/youth/casestudies/CFS42_Youth_Africa_Farmerline.pdf)
- Cooke, E. and Hague, S. (2016) *The Ghana Poverty and Inequality Report: Using the 6th Ghana Living Standards Survey*, Accra, Ghana: UNICEF
- Cudjoe, G., Breisinger, C. and Diao, X. (2010) 'Local impacts of a global crisis: Food price transmission, consumer welfare and poverty in Ghana', *Food Policy*, 35(4), 294–302
- Darfour, B. and Rosentrater, K.A. (2016) 'Agriculture and Food Security in Ghana', paper presented at the 2016 ASABE Annual International Meeting
- Debrah, S.K. and Asare, I.K. (2013) 'Using ICT to Overcome Constraints in the Agriculture Value Chain: Emerging Trends' in *Ghana Enterprise, Resource planning: Concepts, Methodologies and Tools*, Hershey: IGI Global, 689–99
- Deere, C.D., Oduro, A.D., Swaminathan, H. and Doss, C. (2013) 'Property rights and the gender distribution of wealth in Ecuador, Ghana and India', *The Journal of Economic Inequality*, 11(2), 249–65
- DHS, GSS, Noguchi Memorial Institute for Medical Research and ORC Macro. MEASURE/DHS+ (2015) *Ghana Demographic and Health Survey, 2014*, Accra: Ghana Statistical Service

Directorate of Agricultural Extension Services (2011) *Agricultural extension approaches being implemented in Ghana*, Ghana: Directorate of Agricultural Extension Services

Duncombe, R. (2012) *Mobile phones for agricultural and rural development: A literature review and future research directions*, Centre for Development Informatics, Institute for Development Policy and Management, SED (University of Manchester)

Ecker, O., Tan, J.-F.T., Alpuerto, V. and Diao, X. (2012) *Economic Growth and Agricultural Diversification Matters for Food and Nutrition Security in Ghana*, Washington DC: IFPRI, [www.researchgate.net/profile/Olivier\\_Ecker/publication/266374540\\_Economic\\_Growth\\_and\\_Agricultural\\_Diversification\\_Matters\\_for\\_Food\\_and\\_Nutrition\\_Security\\_in\\_Ghana/links/542d9a0d0cf27e39fa9450df.pdf](http://www.researchgate.net/profile/Olivier_Ecker/publication/266374540_Economic_Growth_and_Agricultural_Diversification_Matters_for_Food_and_Nutrition_Security_in_Ghana/links/542d9a0d0cf27e39fa9450df.pdf)

Egyir, I.S., Al-Hassan, R. and Abakah, J. (2011) 'ICT-based Market Information Services Show Modest Gains in Ghana's Food Commodity Markets', paper presented at conference on Development on the Margin, University of Bonn, October

Esoko (2015) *Connecting Farmers*, <https://esoko.com/connecting-farmers/#more-2144> (accessed 23 May 2016)

Esoko (2014) *What's voice got to do with it?*, <https://esoko.com/whats-voice-got-to-do-with-it/> (accessed 23 April 2016)

FAO (2015) *Ghana: Country factsheet on food and agriculture policy trends*, [www.fao.org/3/a/i4490e.pdf](http://www.fao.org/3/a/i4490e.pdf) (accessed 19 June 2016)

FAO (2012) *Gender Inequalities in Rural Employment in Ghana: An Overview*, Rome: FAO

FAO (2010) *Nutrition profile Ghana*, [www.fao.org/ag/agn/nutrition/gha\\_en.stm](http://www.fao.org/ag/agn/nutrition/gha_en.stm) (accessed 26 June 2016)

FAO (2005) *Fertilizer use by crop in Ghana*, Accra, Ghana: FAO

Farmerline (2015) *Farmerline Hosts Workshops for Women in Agriculture*, <http://farmerline.co/tag/ghana/> (accessed 23 April 2016)

Farming First (2009) *Empowering African Cooperatives to Access Markets*, *Farming First*, [www.farmingfirst.org/tag/tradenet/](http://www.farmingfirst.org/tag/tradenet/) (accessed 26 July 2016)

GAIN (2012) *Ghana: Nutrition landscape analysis*, New York: GAIN

Ghana Statistical Service (2014) *Ghana Living Standard Survey Round 6: Poverty Profile Ghana*, Accra, Ghana: Ghana Statistical Service

Ghana Statistical Service (2013) *Population and Housing Census Report 2010 in Ghana*, Accra, Ghana: Ghana Statistical Service

GSS, GHS and ICF International (2015) *Ghana Demographic and Health Survey 2014*, Rockville, MD: GSS, GHS and ICF International

Hesselberg, J. and Yaro, J.A. (2006) 'An assessment of the extent and causes of food insecurity in northern Ghana using a livelihood vulnerability framework', *GeoJournal*, 67(1), 41–55

- Hoq, K.M.G. (2014) 'Rural library and information services, their success, failure and sustainability A literature review', *Information Development*
- Houssou, N., Chapoto, A. and Asante-Addo, C. (2016) *Farm transition and indigenous growth: The rise to medium- and large-scale farming in Ghana*, Washington DC: IFPRI
- Houssou, N., Johnson, M., Kolavalli, S. and Asante-Addo, C. (2016) *Changes in Ghanaian farming systems: Stagnation or a quiet transformation?*, Washington DC: IFPRI
- IFDC (2012) mFarms ICT Platform Launched, <https://ifdc.org/2012/11/05/mfarms-ict-platform-launched/> (accessed 26 July 2016)
- IFPRI (2010) Transforming Agriculture: The Case of Tomato in Ghana, [www.ifpri.org/news-release/transforming-agriculture-case-tomato-ghana](http://www.ifpri.org/news-release/transforming-agriculture-case-tomato-ghana) (accessed 24 July 2016)
- Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Tapio-Bistrom, M.-L. (2016) 'Understanding gender dimensions of agriculture and climate change in smallholder farming communities', *Climate and Development*, 8(2), 133–44
- Kemausuor, F., Akowuah, J. O. and Ofori, E. (2013) 'Assessment of Feedstock Options for Biofuels Production in Ghana', *Journal of Sustainable Bioenergy Systems*, 3(2), 119–128
- Kolavalli, S., Robinson, E.J., Diao, X., Alpuerto, V., Folledo, R., Slavova, B. and Ngeleza, G.K. (2015) *Economic transformation in Africa: Where will the path Lead?*, Washington DC: IFPRI
- Kuivanen, K., Michalscheck, M., Descheemaeker, K., Adjei-Nsiah, S., Mellon-Bedi, S., Groot, J. and Alvarez, S. (2016) 'A comparison of statistical and participatory clustering of smallholder farming systems – A case study in Northern Ghana', *Journal of Rural Studies*, 45, 184–98
- Kwadzo, M. (2014) 'Emerging agricultural extension approach among local Ghanaian farmers: application of Paulo Frère's empowerment education model in supervised extension projects', *Journal of Emerging Trends in Educational Research and Policy Studies*, 5(6), 650–55
- Laar, A. and Aryeetey, R. (2014) 'Nutrition of women and children: Focus on Ghana and HIV/AIDS', *Public Health Nutrition: Principles and practice in community and global health*, USA: Michael Brown
- Langer, A. (2010) 'The Situational Importance of Ethnicity and Religion in Ghana', *Ethnopolitics*, 9(1), 9–29
- Leturque, H., and Wiggins S. (2011) *Ghana's sustained agricultural growth: Putting underused resources to work*, London: Overseas Development Institute
- Ling, R. and Horst, H.A. (2011) 'Mobile communication in the global south', *New Media and Society*, 363–74
- Ministry of Food and Agriculture (2014) *Women in Agricultural Development Directorate*, Accra, Ghana: Ministry of Food and Agriculture, [http://mofa.gov.gh/site/?page\\_id=90](http://mofa.gov.gh/site/?page_id=90) (accessed 24 June 2016)
- Ministry of Food and Agriculture (2013) *Agriculture in Ghana: Facts and Figures*, Accra, Ghana: Ministry of Food and Agriculture

Ministry of Food and Agriculture (2010) *Ministry of Food and Agriculture: Vision*, Accra, Ghana: Ministry of Food and Agriculture, [http://mofa.gov.gh/site/?page\\_id=56](http://mofa.gov.gh/site/?page_id=56) (accessed 24 June 2016)

Ministry of Food and Agriculture (2002) *Agricultural extension policy*, Accra, Ghana: Ministry of Food and Agriculture

Nagasaki, T. (2014) 'Farmerline: using mobile phones to help farmers in Ghana', *The Guardian*, 17 December, [www.theguardian.com/sustainable-business/2014/dec/17/farmerline-mobile-phones-farmers-technology-ghana](http://www.theguardian.com/sustainable-business/2014/dec/17/farmerline-mobile-phones-farmers-technology-ghana) (accessed 23 March 2016)

National Communications Authority (2016) *Industry Information – Telecom subscription for April 2016*, Accra, Ghana: National Communications Authority

Oppong-Anane, K. (2006) *Country Pasture/Forage Resource Profiles: Ghana. Vol. 11*, Rome: FAO

Owusu, K. and Waylen, P.R. (2013) 'The changing rainy season climatology of mid-Ghana', *Theoretical and Applied Climatology*, 112(3–4), 419–30

Owusu, V., Abdulai, A. and Abdul-Rahman, S. (2011) 'Non-farm work and food security among farm households in Northern Ghana', *Food Policy*, 36(2), 108–18

Oxford Business Group (2015) *Ghana's telecoms operators eye expansion*, [www.oxfordbusinessgroup.com/news/ghana%E2%80%99s-telecoms-operators-eye-expansion](http://www.oxfordbusinessgroup.com/news/ghana%E2%80%99s-telecoms-operators-eye-expansion) (accessed 24 July 2016)

PEW Research Centre (2015) *Cell Phones in Africa: Communication Lifeline*, [www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/](http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/) (accessed 24 July 2016)

Pollack, S.L. (2001) 'Consumer demand for fruit and vegetables: the US example', *Changing structure of global food consumption and trade*, 6, 49–54

Quist, E. (2016) *Gov't rescinds decision to scrap tax on mobile phone imports*, <http://pulse.com.gh/business/ministry-of-finance-govt-rescinds-decision-to-scrap-tax-on-mobile-phone-imports-id4645152.html> (accessed 23/06/2016)

Rau, A. (2015) *How Ghana Reduced Hunger and Malnutrition*, <http://borgenproject.org/ghana-reduced-hunger-malnutrition/> (accessed 15/06/2016)

Ruel, M.T., Deitchler, M. and Arimond, M. (2010) 'Developing simple measures of women's diet quality in developing countries: overview', *The Journal of Nutrition*, 140(11), 2048S–2050S

Sam, S. (2016) Private sector increases agric spending, *BFTonline*, <http://thebftonline.com/business/agribusiness/17064/private-sector-increases-agric-spending-.html> (accessed 26 June 2016)

Schneider, S. (2015) 'Five Ways Cell Phones are Changing Agriculture in Africa', *Foodtank*, 25 January, <http://foodtank.com/news/2015/01/five-ways-cell-phones-are-changing-agriculture-in-africa> (accessed 21/04/2016)

Send Ghana (2014) 'Women and Smallholder Agriculture in Ghana', *Policy Brief*, 4(4)

Sey, A. (2011) “‘We use it different, different’”: Making sense of trends in mobile phone use in Ghana’, *New Media and Society*, 13(3), 375–90

Statistics Research and Information Directorate (2012) *Agriculture in Ghana*, Accra, Ghana: Statistics, Research and Information Directorate

Subervie, J. (2011) ‘Evaluation of the Impact of a Ghanaian Mobile-based MIS on the First Few Users Using a Quasi-Experimental Design’, paper presented at the Workshop on African Market Information Systems, November

Swinburn, B.A., Caterson, I., Seidell, J.C. and James, W. (2004) ‘Diet, nutrition and the prevention of excess weight gain and obesity’, *Public Health Nutrition*, 7(1a), 123–46

Tamale, A.-K. F. (2012) ‘The Mfarms Platform: A business solution for agriculture’, *News Ghana*, [www.newsghana.com.gh/the-mfarms-platform-a-business-solution-for-agriculture/](http://www.newsghana.com.gh/the-mfarms-platform-a-business-solution-for-agriculture/) (accessed 25 July 2016)

UNDP (2014) *Human Development Report 2015: Briefing note for countries on the 2015 Human Development Report – Ghana*, <http://hdr.undp.org/en/countries/profiles/GHA> (accessed 21 July 2016)

UNICEF (2013) *At a glance: Ghana*, [www.unicef.org/infobycountry/ghana\\_statistics.html](http://www.unicef.org/infobycountry/ghana_statistics.html) (accessed 18 July 2016)

UNICEF (1990) *Strategy for improved nutrition of children and women in developing countries. Policy Review Paper E/ICEF/1990/1.6*, New York: UNICEF

Vodafone (2015) *Farmers' Club: Esoko*, <http://support.vodafone.com.gh/customer/en/portal/articles/2024908-farmers'-club-esoko-> (accessed 23 May 2016)

WFP (2016) *Ghana*, [www.wfp.org/node/3467](http://www.wfp.org/node/3467) (accessed 23 March 2016)

WFP (2012) *Comprehensive Food Security and Vulnerability Analysis Ghana 2012: Focus on Northern Ghana*, Rome: World Food Programme

WHO (2015) *Country profile: Ghana*, [www.who.int/countries/gha/en/](http://www.who.int/countries/gha/en/) (accessed 23 March 2016)

Wood, T.N. (2013) *Agricultural development in the northern savannah of Ghana*, University of Nebraska

World Bank (2016) *Country profile: Ghana*, [www.worldbank.org/en/country/ghana](http://www.worldbank.org/en/country/ghana) (accessed 18 June 2016)

World Bank (2015) *Overview Ghana*, [www.worldbank.org/en/country/ghana/overview#1](http://www.worldbank.org/en/country/ghana/overview#1) (accessed 24 July 2016)

World Bank (2014) *Mobile at the Base of the Pyramid: Ghana*, Washington, DC: World Bank

World Bank and FAO (2014) *Cereal yields (KG per Hectare)*, [http://data.worldbank.org/indicator/AG.YLD.CREL.KG?year\\_high\\_desc=false](http://data.worldbank.org/indicator/AG.YLD.CREL.KG?year_high_desc=false) (accessed 24 July 2016)

World Cocoa Foundation (2013) *CocoaLink – Connecting Cocoa Communities: Ghana*, [www.worldcocoafoundation.org/cocoalink/](http://www.worldcocoafoundation.org/cocoalink/) (accessed 23 January 2016)

Yiridoe, E.K. and Anchirinah, V.M. (2005) 'Garden production systems and food security in Ghana: Characteristics of traditional knowledge and management systems', *Renewable Agriculture and Food Systems*, 20(3), 168–80

Zakaria, H. and Laribick, D.B. (2014) 'Socio-Economic Determinants of Dietary Diversity among Women of Child Bearing Ages in Northern Ghana', *Food Science and Quality Management*, 34, [www.iiste.org/Journals/index.php/FSQM/article/view/18195/18570](http://www.iiste.org/Journals/index.php/FSQM/article/view/18195/18570) (accessed 24 July 2016)